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> single-celled organism such as paramecium, it in turn is obliged, with all its parts and its partners, to follow along a trail of events in time and space determined largely by the extrinsic overall dynamics of *Paramecium caudatum*. When it comes to brains, remember that the simpler electric, atomic, molecular, and cellular forces and laws, though still present and operating, have been superseded by the configurational forces of higher-level mechanisms. At the top, in the human brain, these include the powers of perception, cognition, reason, judgment, and the like, the operational, causal effects and forces of which are equally or more potent in brain dynamics than are the outclassed inner chemical forces. (Sperry 1964)

The fact that these earlier explanations of macro-determination are not mentioned by Klee despite their direct relevance to his argument and to subsequent views he cites of Polanyi, Pattee, Paul Weiss, and Donald Campbell, and others leads one to wonder if Klee had been acquainted with their contents.

The later illustration I used in 1969 of a wheel rolling downhill may be, as Klee interprets, only an analogy or metaphor in reference to consciousness, but in reference to macro-determinism it is a direct, simple, objective, physical example of macro-causation illustrating the universal principle of how the emergent properties of an entity as a whole exert downward causal control over the parts and the trajectories of the parts through space and time without interfering with the causal interactions of the subentities at their own lower levels.

To help explain why a strict micro-determinism cannot fully account for the wheel example or for other emergent properties, I have repeatedly stressed the important causal role of the nonmaterial space-time, pattern, or form factors and suggested that it is helpful to view any entity as not just a collection of material parts but as a mass-energy-space-time manifold built of space-time components as well as of matter. The emergent properties of the entirety and the laws for its causal interactions are determined by the spacing and timing of the parts as well as by the properties of the parts themselves. The very essence of evolutionary progress is in the new timing and the new spacing of the parts. Klee, however, largely ignores these critical spacing and timing factors in the traditional fashion of materialist philosophy: "a biological system is undoubtedly composed entirely of matter as are neurobiological systems" (p. 46).

Indirect allusion to the spatio-temporal determinants in the phrase "relational structures" is less helpful than misleading in so far as it implies that the spatial and temporal relations of the parts to each other in any newly emerged system are determined strictly by the properties of the

parts. In some cases this may be true, especially at molecular and lower levels, but in general the causally critical space-time relationships are simply not accounted for in materialist or micro-determinist philosophy. One can account for the "new relational structure" at higher evolutionary levels only by including the already emerged properties of the parts. Although one may account for the formation of a new structure, like the DNA molecule, in terms of the parts, this does not give an explanation or laws for the way the new entity, because of its spiral form, for example, will thereafter behave and thereby control the fate of its parts. None of Klee's analyses serves to answer another physical example I have used (Baskin and Sperry 1983) that compares five identical populations of copper, silver, or other atoms molded into five different shapes exhibiting five distinct sets of causal laws or properties despite being composed of identical *material* parts.

There is no conflict with the scientific assumption that evolution can be traced backward through time in a continuous deterministic progression eventually to atomic and subatomic elements. It may be argued that the new wholes that emerge at each step are largely micro-determined by the laws and properties of the pre-existent parts (among other things), but this misses the point. What matters is that the movement and fate of the parts from that time onward, once a new whole is formed, are thereafter governed by entirely new macro-properties and laws that previously *did not exist*, because they are properties of the new configuration—as in the example of the rolling wheel. Further, it must be remembered that after the evolutionary process is established and under way, the parts from which new wholes are created have already been endowed in most cases with multi-nested emergent or macro-properties. Macro-determinism thus begins to be superimposed upon micro-determinism from the earliest stages onward and grows by a compounding process into increasing prominence as evolution progresses.

In dismissing the case for macro-causation as being "too weak to be conclusive," Klee overlooks the recent 'consciousness' or 'mentalist' revolution in the mind-brain and behavioral sciences. Essentially this revolution involved a shift from long prevalent micro-determinist concepts to a new macro-determinist interpretation of consciousness and brain function in a conceptual conversion that occurred in psychology with almost explosive suddenness in the early 1970s (Pylyshyn 1973; Hilgard 1980). The older behaviorist-materialist doctrine that had renounced the use of conscious or mental phenomena in scientific explanation gave way before a new acceptance of mental entities as causal constructs. In former 'parallelist' and 'identity' conceptions of mind the subjective aspects of brain activity had been interpreted to be dispensible and outside scientific explanation; whereas in the new causal 'interactionist' view the conscious properties, as emergents of brain processing, become integral and ineliminable explanatory constructs.

The strong, traditional micro-determinist position, which is time-tested, deeply entrenched over decades and consistently and powerfully reinforced by advancements in neuroscience, is not something that would be overthrown or replaced by an alternative that is 'weak'. No other argument had the power or justification in logic to overthrow and displace the highly convincing claim that a complete account of brain function and behavior is possible in strictly neurological, even physico-chemical terms (eventually in quantum field theory) without any reference to the introspective conscious properties. The recent overthrow in psychology of this seemingly impregnable position succeeded, not so much by negating or displacing micro-determinism, but rather by supplementing it. Micro-determinism is retained but is held to be incomplete, insufficient. The properties, forces and laws of micro-events are shown to be encompassed and superseded, not disrupted, by the properties, forces, and laws at macro-levels.

Meantime, various groups have been inclined to attribute the consciousness revolution to other developments within their own areas, for example in humanistic and cognitive psychology, in information theory and computer science, psychotherapy and psychosomatic disciplines, and in various holistic and consciousness-raising movements. The tenets of cognitive theory, however, and of humanistic psychology, psychosomatics, holism, computer, information and hierarchic theory had been around a long time without having posed a major threat to the prevalent behaviorist paradigm. Cognitive and other 'macro' states always had their neural and other 'micro' correlates to which objective science could point as the real causal agents—a position which Klee and many others, of course, still favor. It was not until after explicit macro-determinist concepts of downward causal control by macro mental events over the micro neural correlates had been introduced and had had a few years to disseminate and to infuse and potentiate the holistic and subjectivist predications in these various 'cognitive' areas that the collective impact began to cascade into a mounting rejection of the behaviorist paradigm in favor of the new acceptance of mental properties as ineliminable causal constructs.

Computer science underwent parallel developments during the same period. Through the mid-sixties computer program operations along with their electronic and other related micro-physical processes, when compared to mind and brain, were viewed as a single, unified process for which one can see two descriptions on two different levels with "two languages," "two logics," each valid and complete, but always as "complementary aspects of one and the same situation" (MacKay 1966, 1980).

Strict micro-physical determinism was preserved. Again this kind of thinking changed during the 1970s, until today many agree that the 'macro' computer software programs exert downward causal control over their electronic and other microphysical correlates and, just like the conscious mental programs in the brain, have their own dynamics, properties, and laws of progression and interaction distinctly different from those of the underlying microphysics.

In view of this increasing recognition and acceptance of macro-determinism in the behavioral, computer, and cognitive sciences, and with increasing signs of its spread into neighboring disciplines, it would appear that the case for macro-determinism is stronger than Klee infers. The issues at stake are hardly trivial or ivory tower. If the micro-determinists are correct—and I take their position to be essentially that of traditional scientific materialism or physicalism—then we live in a cosmos driven entirely by physical forces of the most elemental kind, that is, quantum mechanics, the four fundamental forces of physics, or some even more elemental unifying field force yet to be discovered. These are the forces that are in control, the forces that made and move the universe and created man. On these terms there is no higher meaning, no values, no purpose, no choice, nor any spirituality or moral priority.

On the other hand, if we are correct about macro-determination, or 'emergent determinism', these lower-level physical forces, though still active, are successively enveloped, overwhelmed, and superseded by the emergent forces of higher and higher levels that in our own biosphere include vital, mental, political, religious, and other social forces of civilization (Sperry 1983). The result is a vastly transformed scientific view of human and nonhuman nature. Organic evolution becomes a gradual emergence of increased directedness or purposefulness and meaning among the forces and properties that move and govern living things. Scientific descriptions are no longer in utter conflict with traditional humanist views and values or the search for meaning.

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